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(54) **COLLAPSIBLE/EXTENDABLE ASPIRATOR SYSTEM**

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(52) **U.S. Cl.**

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(58) **Field of Classification Search**

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USPC ..... **441/90**; **137/68.19-69**  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,370,784 A \* 2/1968 Day ..... B63C 9/24  
137/223

3,598,504 A \* 8/1971 Siravo ..... F04F 5/48  
417/184

3,640,645 A 2/1972 Forsythe  
4,566,862 A \* 1/1986 Halavais ..... F04F 5/16  
417/174

4,671,744 A 6/1987 Shaffer et al.  
6,004,176 A 12/1999 Moran  
6,071,084 A 6/2000 Wass  
8,066,493 B2 11/2011 Renz et al.  
2010/0266424 A1 \* 10/2010 Renz ..... F04F 5/463  
417/191

FOREIGN PATENT DOCUMENTS

EP 2243963 10/2010  
FR 2140918 1/1973  
WO 8302981 9/1983

OTHER PUBLICATIONS

Extended European Search Report dated Dec. 6, 2016 in European Application No. 16179899.6.

\* cited by examiner

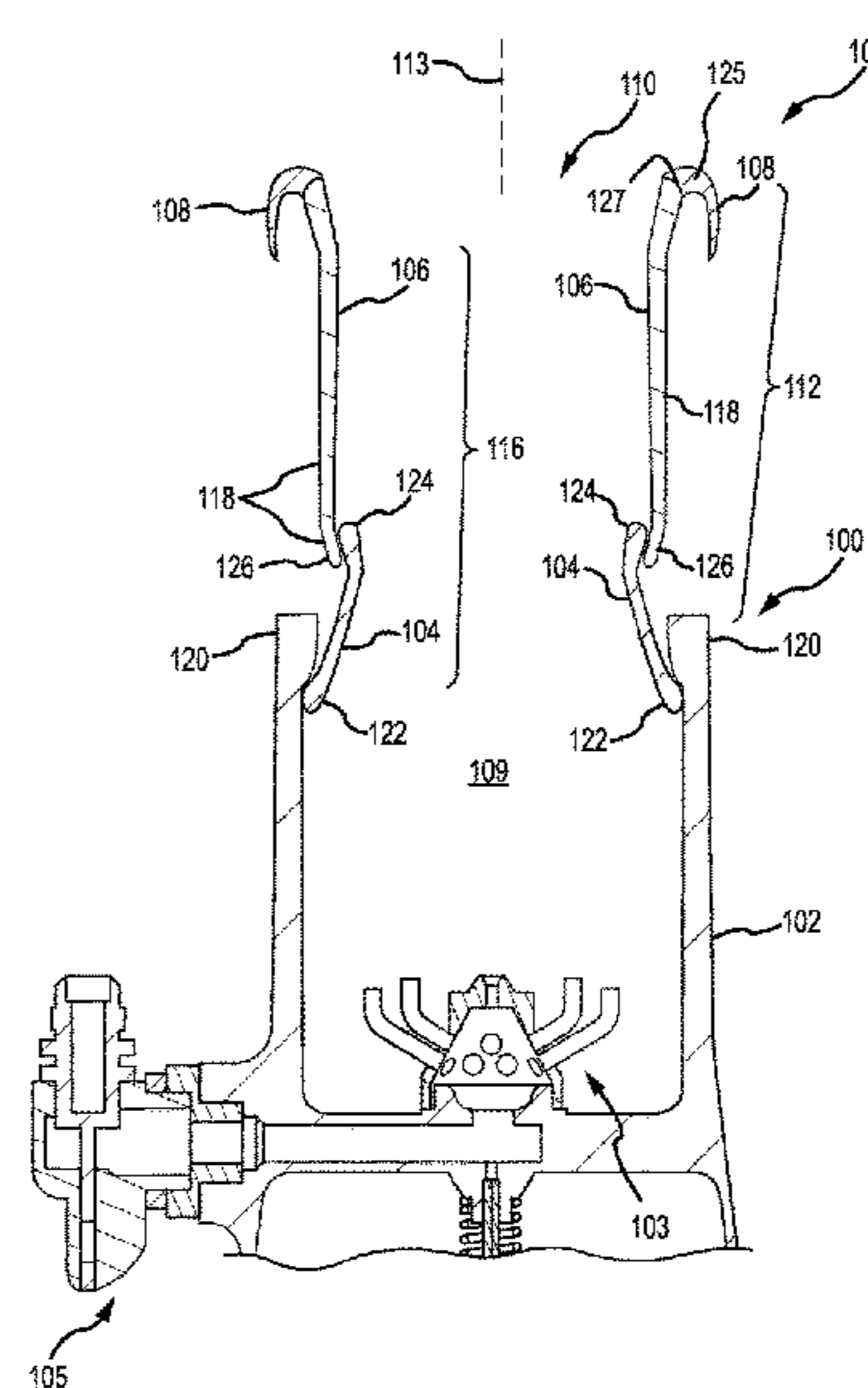
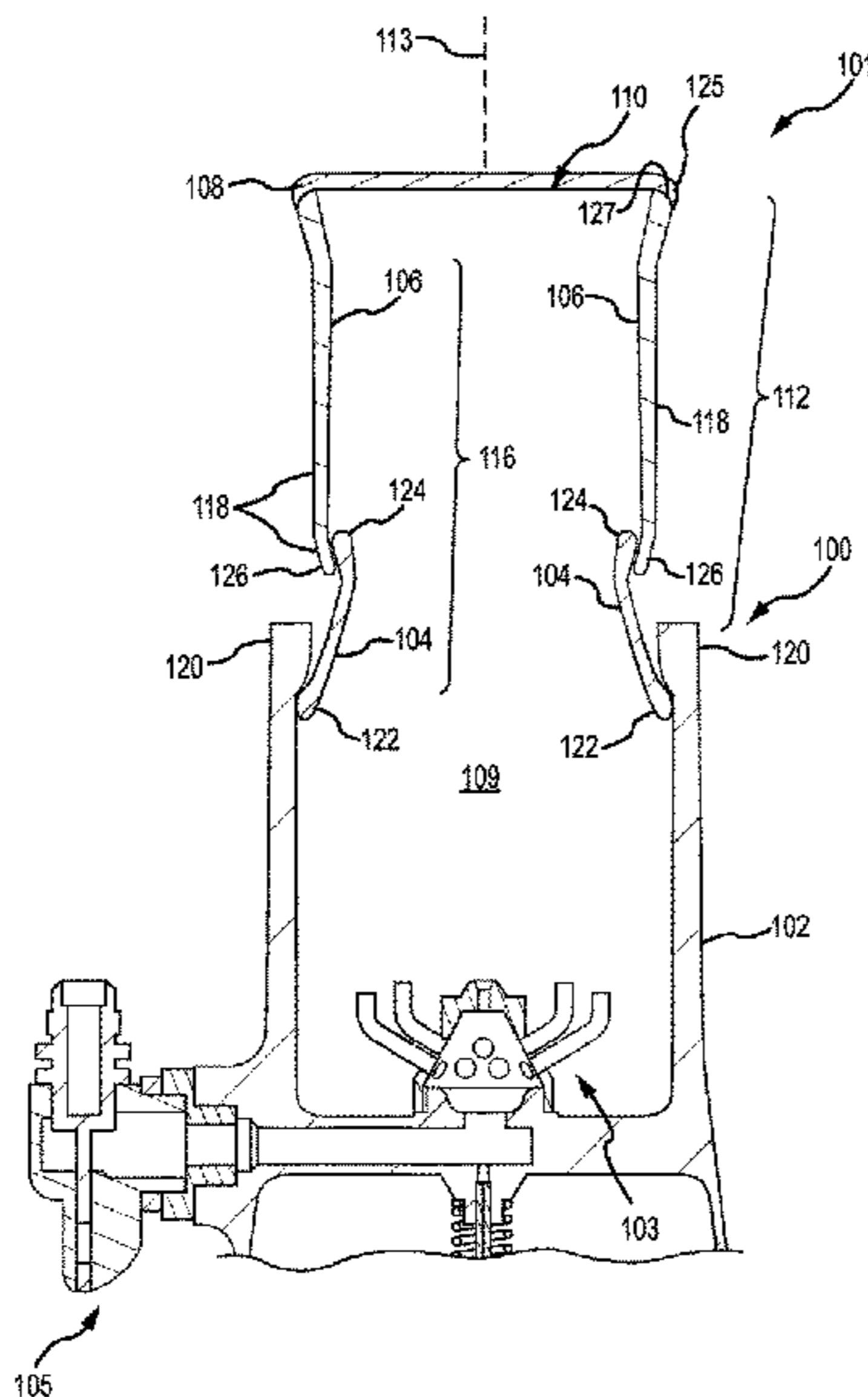
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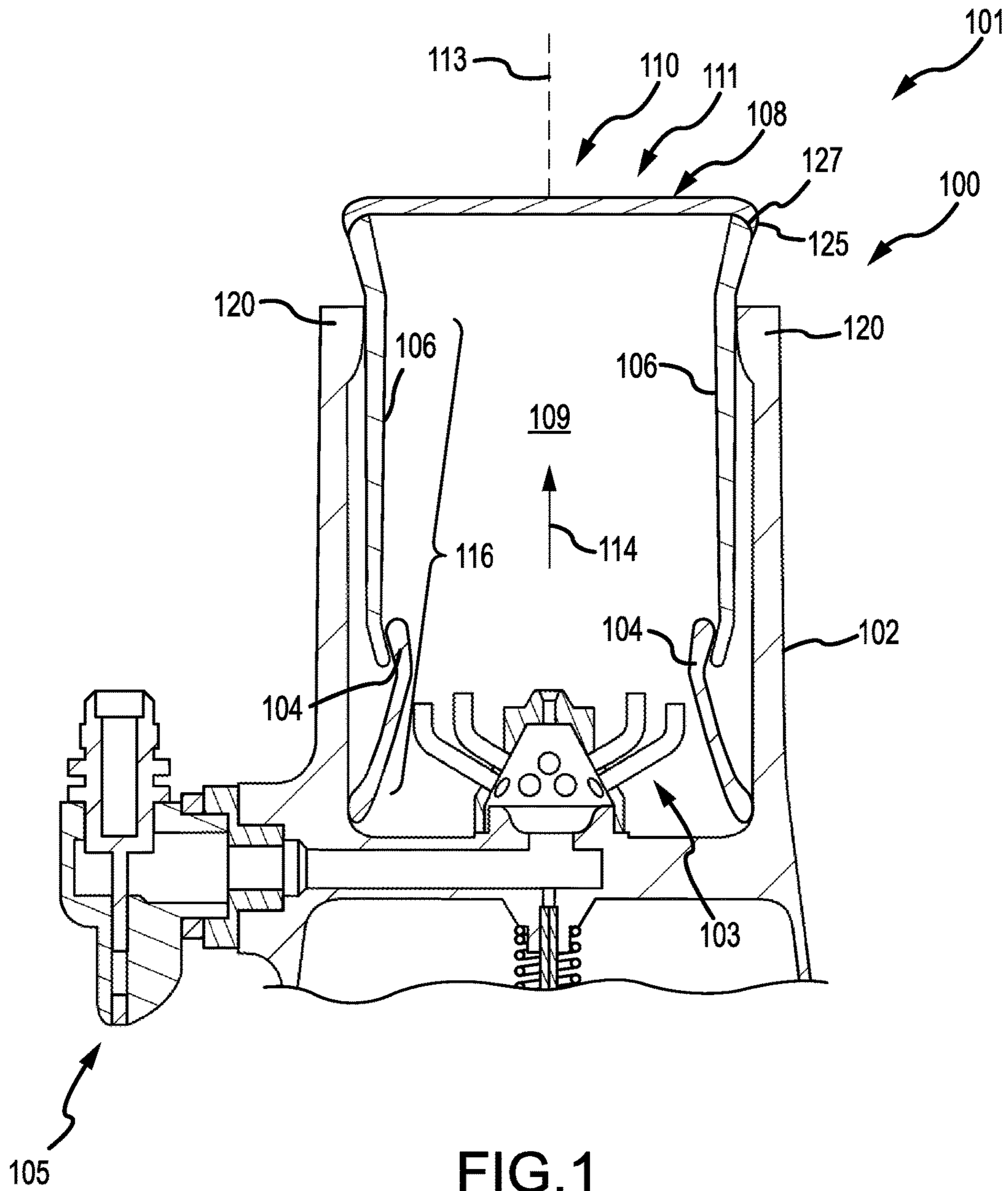
(74) *Attorney, Agent, or Firm* — Snell & Wilmer L.L.P.

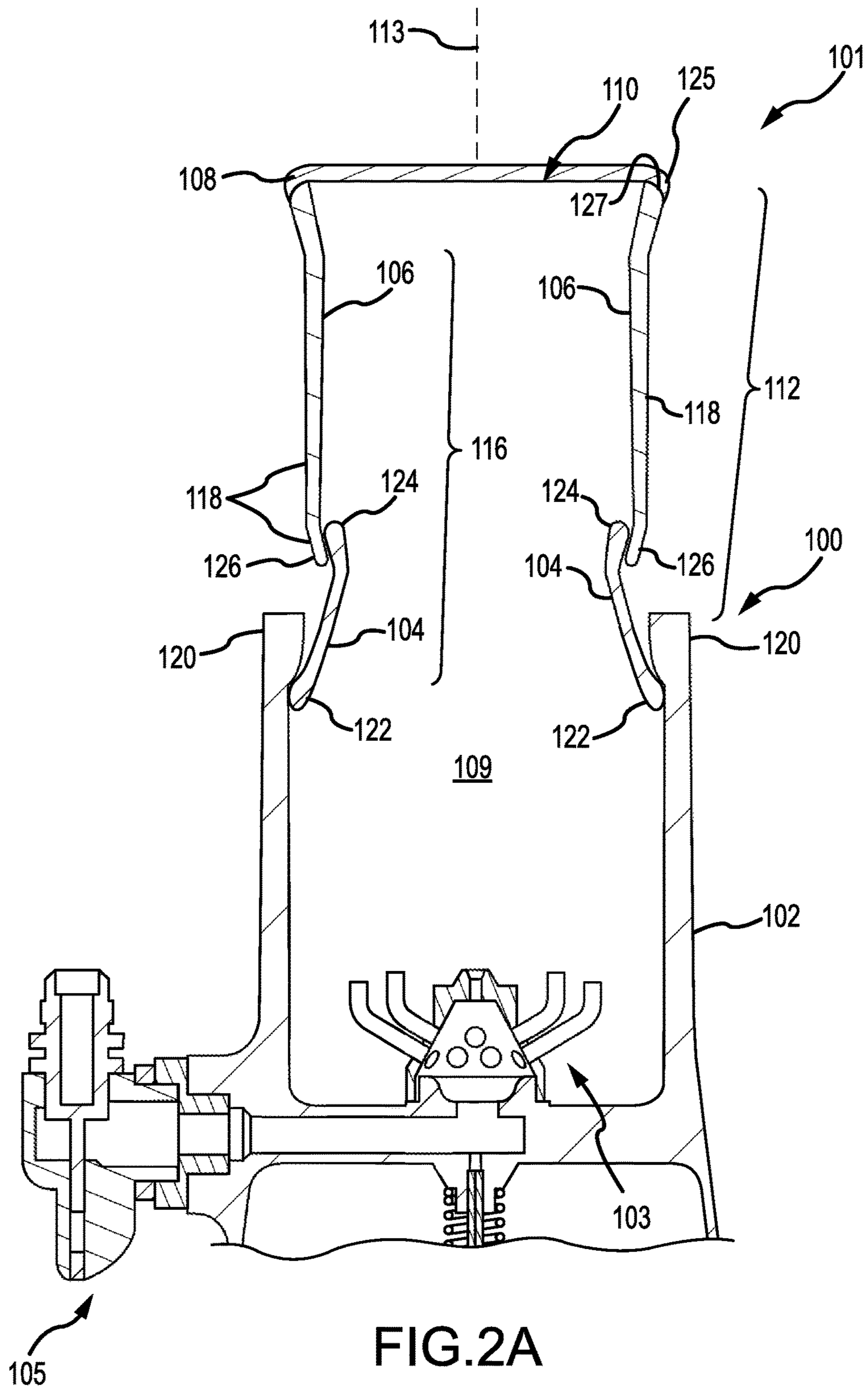
(57) **ABSTRACT**

An aspirator system is disclosed comprising a collapsible/extendable aspirator air channel, wherein a burstable seal for entrapping air across the exit channel is provided, wherein said entrapped air creates a pressure causing the aspirator to extend to its extended state, whereupon the seal bursts and opens the air channel.

**14 Claims, 8 Drawing Sheets**







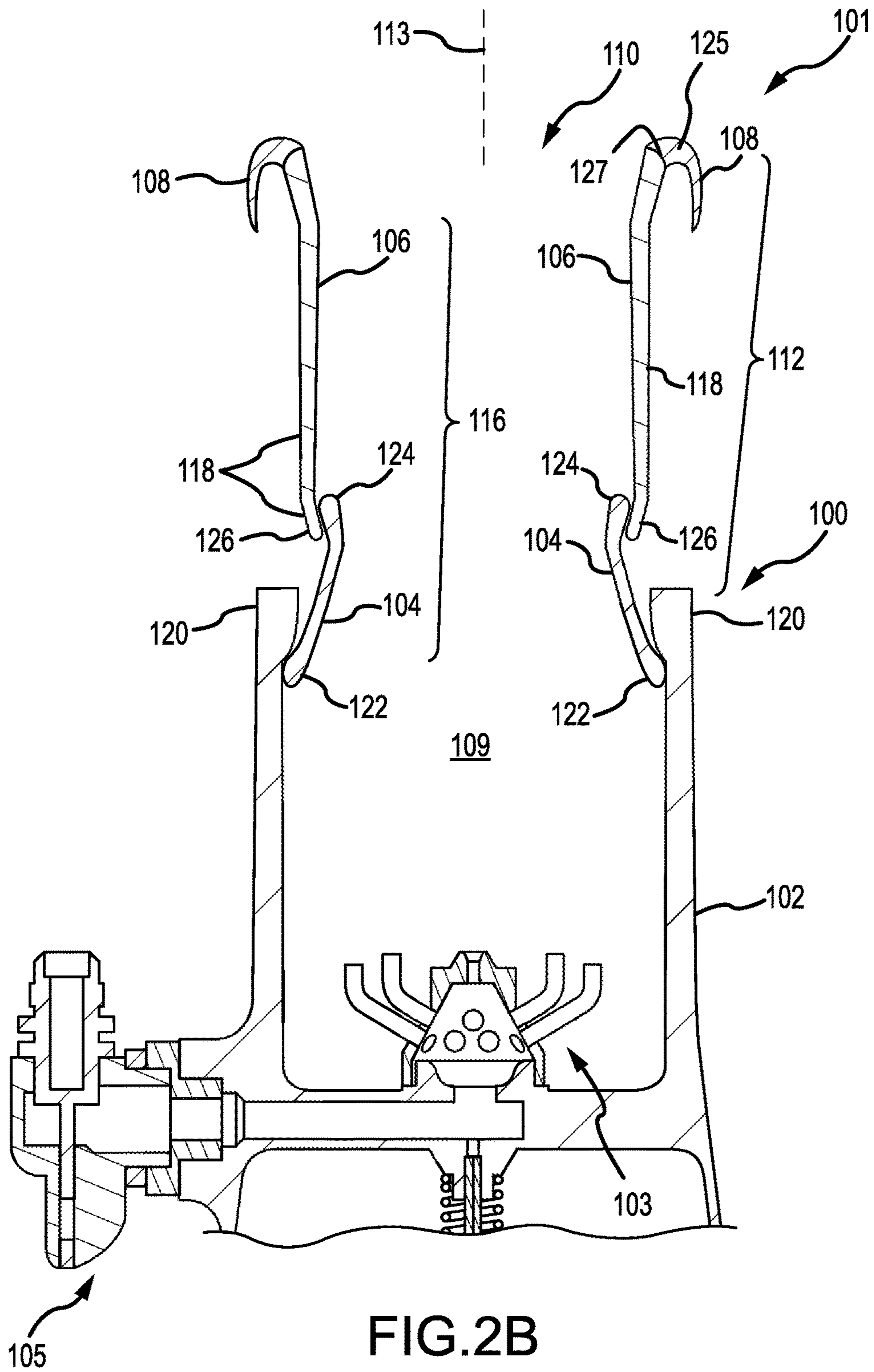


FIG.2B

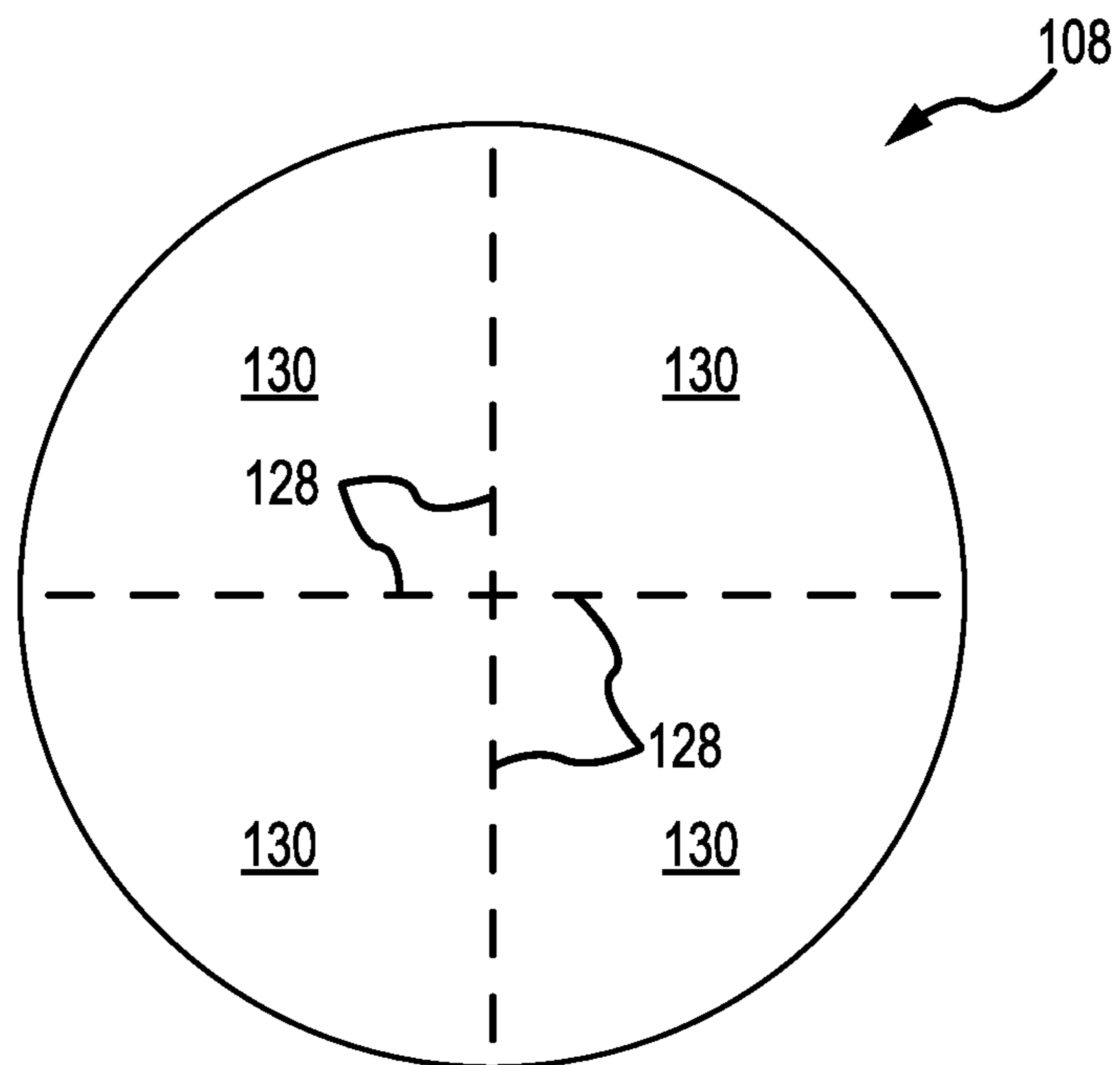
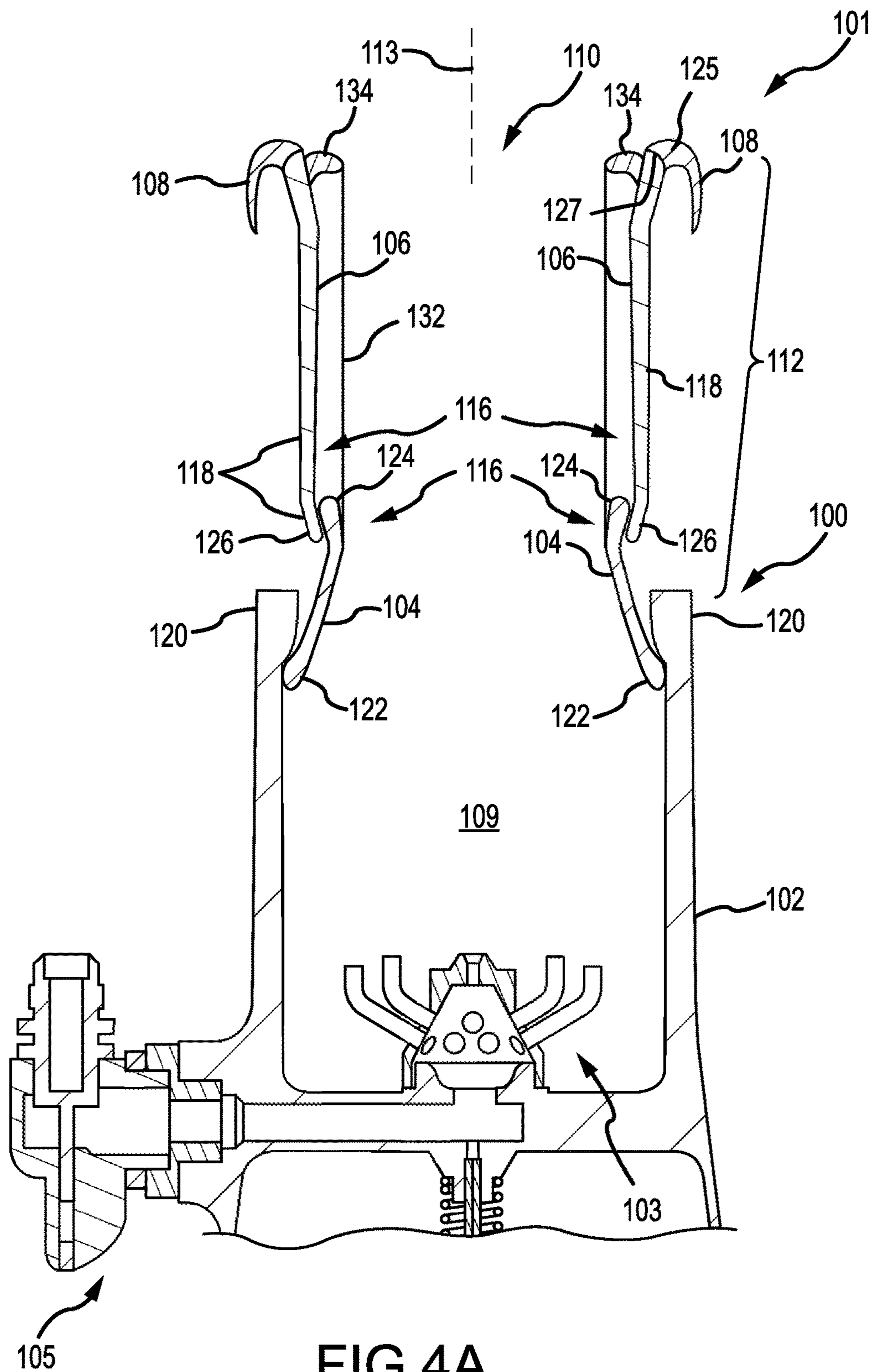
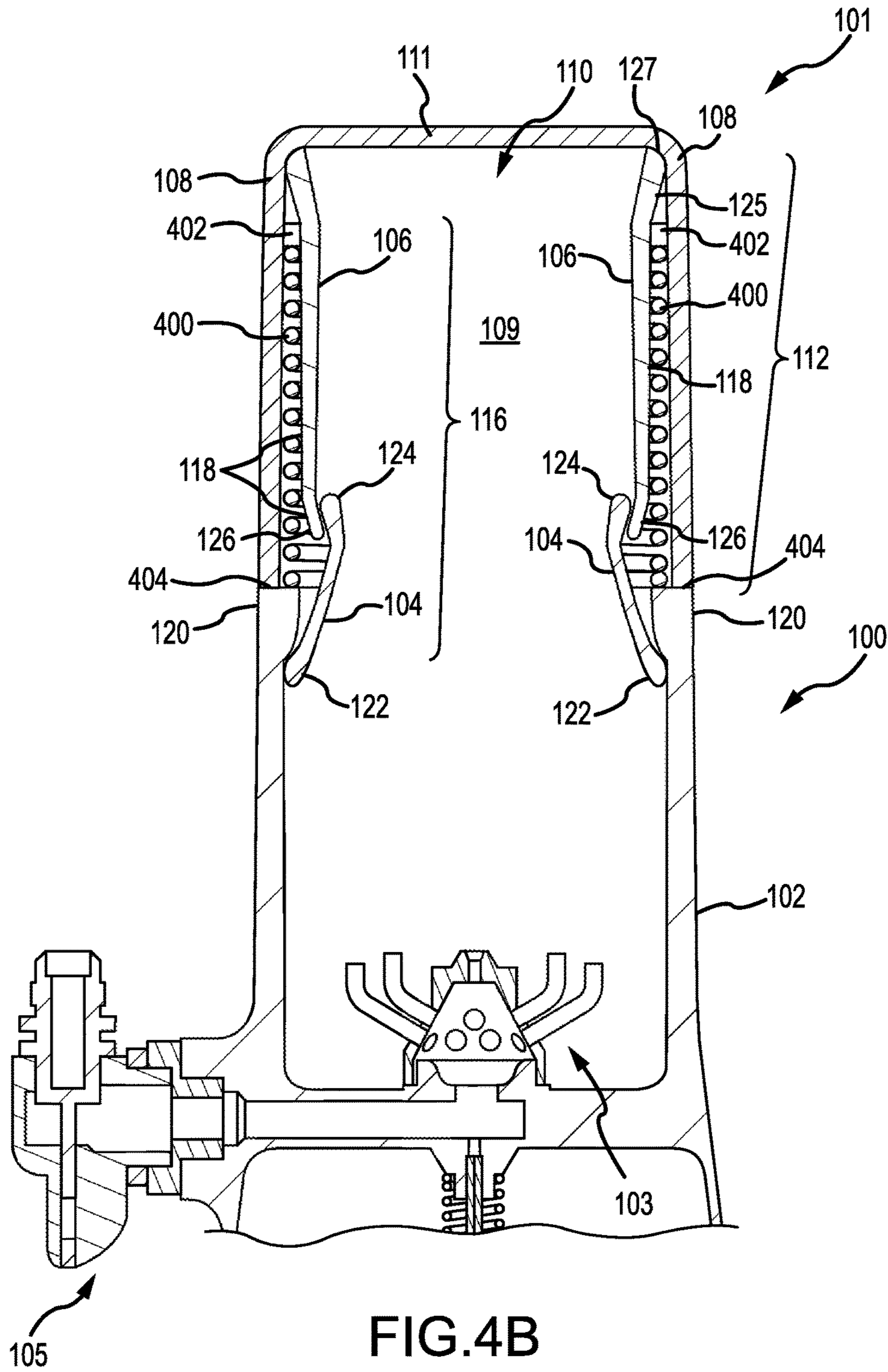


FIG.3A









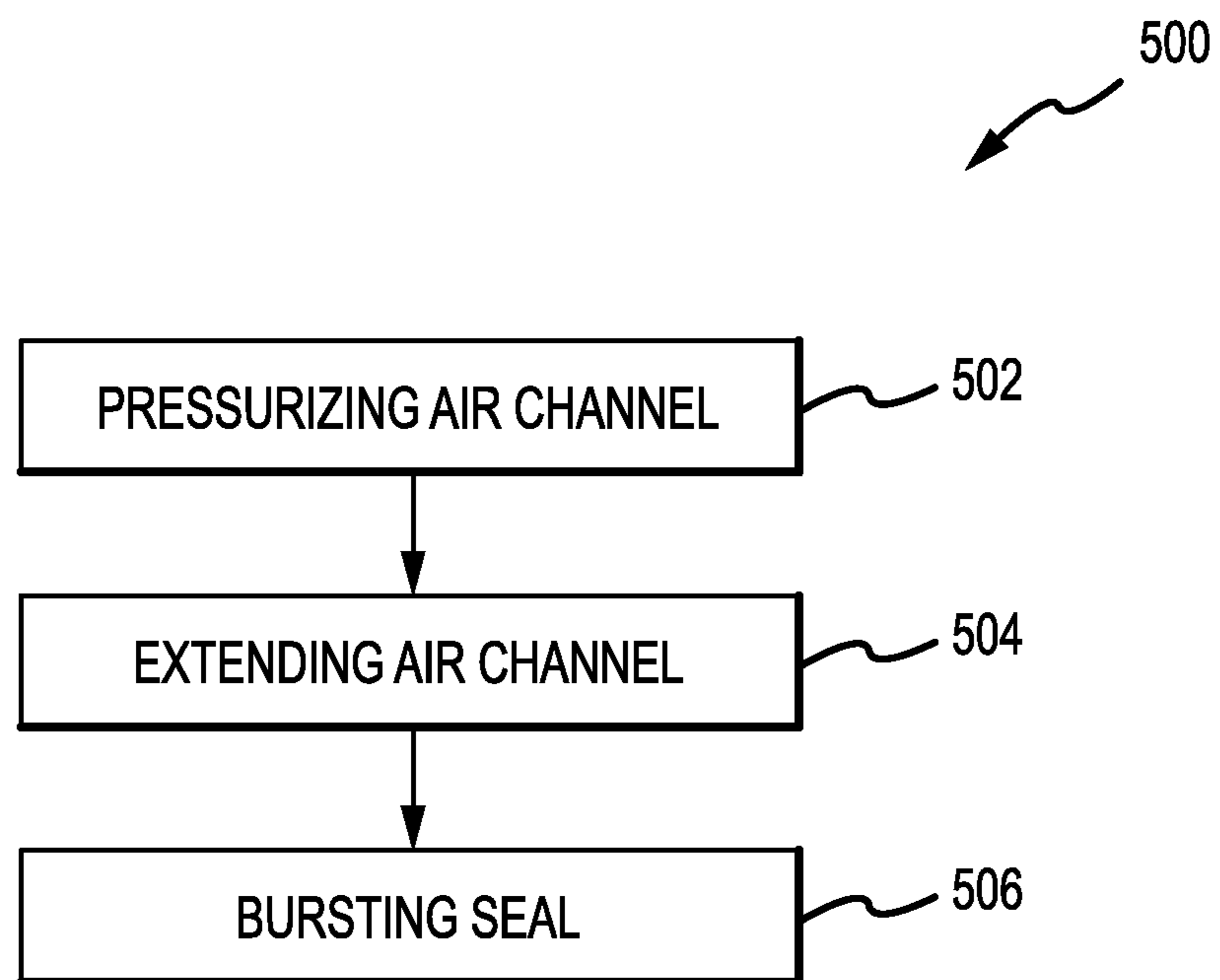


FIG.5

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## COLLAPSIBLE/EXTENDABLE ASPIRATOR SYSTEM

### BACKGROUND

Inflatable emergency evacuation devices such as aircraft evacuation slides, emergency life rafts and similar devices typically include a charged cylinder and an aspirator. Such equipment is typically stored in a limited packing space and thus is often densely packaged. The high package density may lead to various issues including cracked aspirators, which may be fragile. Therefore, it is desirable to minimize the volume of the inflatable emergency evacuation device in its packed condition.

### SUMMARY

In accordance with various embodiments, disclosed is an aspirator system comprising, an air channel movable between a collapsed state and an extended state, said air channel comprising, an aspirator body having a longitudinal axis, an aspirator barrel in translating engagement with said aspirator body, and a nozzle assembly disposed within said aspirator body, and configured to direct gas through said air channel, and a pressure removable block, configured to seal said air channel in said collapsed state, wherein said aspirator barrel is configured to extend from said aspirator body in response to a first pressure, said first pressure created in response to gas directed through said air channel against said pressure removable block, and wherein said pressure removable block is configured to unseal said air channel in response to a second pressure, said second pressure created as gas is directed through said air channel against said pressure removable block.

In one aspect, said aspirator barrel is configured to extend from said aspirator body from a short axial length to an extended axial length along said longitudinal axis, wherein said second pressure is created upon extension of said aspirator barrel to said extended axial length.

In one aspect, said aspirator body further comprising a rim configured to prevent said aspirator barrel from further translation upon extension of said aspirator barrel to said extended axial length.

In one aspect, said second pressure is greater than said first pressure.

In one aspect, wherein said pressure removable block is a rupturable seal configured to tear upon application of said second pressure and bonded at an opening of said aspirator barrel.

In one aspect, wherein said rupturable seal is a fabric.

In one aspect, said rupturable seal comprising a weakened segment, wherein said rupturable seal is designed to tear at said weakened segment.

In one aspect, said aspirator barrel comprising an air channel exit through which said gas is directed, said pressure removable block configured to seal said air channel at said air channel exit.

In one aspect, said aspirator barrel being collapsible, and at least partially retainable within said aspirator body.

In one aspect, further comprising an inflatable device configured to receive gas from said air channel.

In one aspect, said aspirator barrel comprising a first telescoping segment and a second telescoping segment, said first telescoping segment configured to extend from and collapse into said aspirator body, and said second telescoping segment configured to extend from and collapse into said first telescoping segment.

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In one aspect, said air channel further comprising an interior lining member configured to fold in the collapsed state, and extend to form a smooth interior of said air channel in the extended state.

5 In one aspect, said interior lining member comprising a fabric.

In one aspect, an extension holder is configured to apply a mechanical extension force on said air channel.

In one aspect, said extension holder comprising a spring.

10 In various embodiments, an aspirator method is provided comprising pressuring an air channel, said air channel being sealed with a seal, said air channel having extendable channel walls, and being in a collapsed state, extending an aspirator barrel in response to an extending pressure and bursting said seal in response to a burst pressure.

15 In one aspect, wherein the aspirator barrel comprises an extendable channel wall comprising a telescoping segment that is lockable upon extension of said extendable channel wall.

In one aspect, further comprises inflating an inflatable device using said aspirator channel.

20 An aspirator method is provided herein comprising sealing an air channel with a seal to create a pressurizable enclosure, said air channel forming an aspirator system, pressurizing the air channel to form an extending pressure against the seal.

25 In one aspect, further comprises extending an aspirator barrel from an aspirator body of said air channel, retaining said aspirator barrel against an inwardly flared rim of said aspirator body, and pressurizing the air channel to form a burst pressure against the seal.

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### DESCRIPTION OF THE DRAWINGS

The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way. The present disclosure will become more fully understood from the detailed description and the accompanying drawings wherein:

FIG. 1 is a cross-section view of an aspirator system comprising a collapsible/extendable aspirator air channel shown in a collapsed state, in accordance with various embodiments;

FIG. 2A shows the aspirator system of FIG. 1, with the aspirator air channel in an extended state and the seal is intact, in accordance with various embodiments;

45 FIG. 2B shows the aspirator system of FIG. 1, with the aspirator air channel in an extended state and the seal is burst, in accordance with various embodiments;

FIG. 3A is a view of a seal for the aspirator system of FIG. 1, in accordance with various embodiments;

50 FIG. 3B is a perspective view of the aspirator system of FIG. 1, the aspirator air channel shown in its extended state, with a ruptured seal, in accordance with various embodiments;

55 FIG. 4A illustrates the aspirator system of FIG. 1, the aspirator air channel in an extended state, comprising a compressible/extendible internal tube, in accordance with various embodiments;

FIG. 4B illustrates the aspirator system of FIG. 1, the aspirator air channel in an extended state, comprising an extension holder and spring; and

FIG. 5 illustrates an aspirator method, in accordance with various embodiments.

### DETAILED DESCRIPTION

65 All ranges and ratio limits disclosed herein may be combined. It is to be understood that unless specifically

stated otherwise, references to “a,” “an,” and/or “the” may include one or more than one and that reference to an item in the singular may also include the item in the plural.

The detailed description of exemplary embodiments herein makes reference to the accompanying drawings, which show exemplary embodiments by way of illustration and its best mode, and not of limitation. While these exemplary embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, it should be understood that other embodiments may be realized and that logical, chemical and mechanical changes may be made without departing from the spirit and scope of the invention. For example, the steps recited in any of the method or process descriptions may be executed in any order and are not necessarily limited to the order presented. Moreover, many of the functions or steps may be outsourced to or performed by one or more third parties. Furthermore, any reference to singular includes plural embodiments, and any reference to more than one component or step may include a singular embodiment or step. Also, any reference to attached, fixed, connected or the like may include permanent, removable, temporary, partial, full and/or any other possible attachment option. Additionally, any reference to without contact (or similar phrases) may also include reduced contact or minimal contact.

In accordance with various embodiments, shown in the figures is an aspirator system **101** comprising an air channel **100** movable between a collapsed state and an extended state along a longitudinal axis **113**, the air channel **100** including an aspirator body **102**, an aspirator barrel **112**, and a pressure removable block **111**, preferably comprising a seal **108** which is rupturable. Air channel **100** further includes a portion **116** which is collapsible and extendable, and which is preferably at least a portion of the aspirator barrel **112**. Portion **116** or aspirator barrel **112** is at least partially retainable in aspirator body **102**, and is configured to extend from a short axial length to an extended axial length along longitudinal axis **113**. Aspirator body **102** generally houses a nozzle assembly **103**, which is coupled to an air-flow assembly **105** and configured to direct gas through air channel **100**. According to various embodiments, aspirator system **101** further comprises an inflatable emergency evacuation device which may be coupled to air channel **100** at its air channel exit **110**.

During typical use, the nozzle assembly **103** directs primary gas at high velocity from the air-flow assembly **105** (e.g. from a charged cylinder) into the air channel **100**, further causing secondary gas from the outside air to get pulled into air channel **100** due to the Venturi effect. When air channel **100** is in its collapsed and sealed state, air pressure created in response to gas directed through the air channel **100** against the pressure removable block **111** or seal **108** causes the portion **116** and/or aspirator barrel **112** of the air channel **100** to extend along longitudinal axis **113**. This is due to pressure build up as gas fills air channel **100**. Once portion **116** is fully extended, further inflow of gas into the air channel **100** causes further pressure build up, causing seal **108** to break/burst. Once the air channel **100** is fully extended, and seal **108** is broken, gas may be communicated through the air channel **100**.

As shown in the figures, air channel **100** includes an air channel exit **110** wherein rupturable seal (“burst seal” or “burstable seal”) **108** is bonded or otherwise attached across air channel exit **110**, in accordance with various embodiments. When air channel **100** is in its collapsed state (see FIG. 1), wherein the seal **108** is intact prior to bursting, a first air pressure (also referred to an extending pressure) created

by the inflow of gas (depicted by arrow **114**) through the channel interior **109**, from air-flow assembly **105**, against seal **108** translates portion **116** from a collapsed state to its operational, generally extended state (see FIG. 2A), whereupon a second pressure (also referred to as bursting pressure), which is pressure that builds once the volume of channel interior **109** is fixed, causes the seal **108** to burst (see FIG. 2B). Typically, aspirator system **101** is configured such that the second pressure is greater than the first pressure.

In accordance with various embodiments, air channel **100** is generally cylindrical. According to various embodiments, aspirator barrel **112** may be slightly outwardly flared, and/or narrowed with respect to the aspirator body **102**. In accordance with various embodiments, aspirator barrel **112** forms portion **116**, and houses, at least partially within aspirator body **102** in its collapsed state.

Various geometrical configurations and structural arrangements of the air channel are contemplated here, considering such issues as design preference, user preferences, applications, marketing preferences, cost, structural considerations, available materials, hereinafter developed components, etc.,

According to various embodiments, portion **116** comprises one or more collapsible segments. Increasing the number of segments may increase compactness of the air channel **100**, though the levelness and/or evenness of the walls of channel interior **109** may be compromised due to segmentation of the air channel **100**. Thus, in various embodiments, where it may be desirable to provide a leveled channel interior **109**, there may be a tradeoff between functionality and compactness. However, in embodiments including an internal flexible liner (see below) this may be avoided.

According to various embodiments, portion **116** comprises segments which are self-interlocking upon extension. According to various embodiments, the self-interlocking segments are friction interlocking. According to various embodiments, an extension holder such as a spring may be provided to facilitate maintenance of the extended state.

FIG. 1 shows air channel **100** in its collapsed (packed) state, comprising aspirator body **102**, and telescoping segments comprising a first telescoping segment **104**, and a second telescoping segment **106**, (telescoping segments **104**, **106**) which are in a collapsed state, with seal **108** bonded or otherwise attached across the air channel exit **110**. Upon extension of air channel **100** (see FIGS. 2A and B), telescoping segments **104** and **106**, extend to form aspirator barrel **112**.

According to certain embodiments, telescoping segments **104**, **106**, and aspirator body **102** have flanged ends or rims that extend radially inward with respect to aspirator body **102**, which form a friction lock upon full extension, and thus prevent aspirator barrel **112** from further extension. This is illustrated in FIGS. 2A and B, wherein the top rim **120** of aspirator body **102** is shown interlocked with the bottom rim **122** of telescoping segment **104**, and the top rim **124** of telescoping segment **104** is shown interlocked with the bottom rim **126** of telescoping segment **106**. In this regard, the top rim **124**'s flared configuration retains aspirator barrel **112** against aspirator body **102** and resists and/or prevents further axial extension from aspirator body **102**. According to various embodiments, telescoping segments **104**, **106** are made from a plastic or metal material.

A variety of geometric configurations, structural arrangements, and/or materials and/or methods of facilitating interlocking functionality are contemplated herein in consideration of issues such as design preference, user preferences,

applications, marketing preferences, cost, structural requirements, available materials, hereinafter developed technology, etc. For example, the rims may be stepped, the walls may be conical, and/or include interlocking grooves, etc.

According to various embodiments, seal **108** is bonded across air channel exit **110**, around the outer lip **125** of air channel **100**, to form an air-tight closure. According to various embodiments, seal **108** forms a cap bonded at the outer wall **127** of air channel **100**, adjacent to outer lip **125**. Various suitable techniques of adhesion will be apparent to one skilled in the art. For example, the fabric seal may be bonded with urethane based adhesive or may be mechanically fastened by bonding it to a rubber flange that may be attached with a band clamp. Additionally, a ruptured seal may be replaced for reuse.

According to various embodiments, seal **108** is a fabric having a strength suitable to sustain enough pressure for the channel **100** to expand before collapsing, but burst upon full extension. According to various embodiments, it is desirable for the seal **108** to be thin in order to reduce its interference with the channel **100** after bursting. According to various embodiments, a suitable material may include, for example, nylon, rayon, silk, polyester, cotton, ballistic nylon, and neoprene coated nylon. Other suitable materials are contemplated herein. Other geometries of aspirator barrel **112** are contemplated herein.

According to various embodiments, seal **108** may include rupture control sections comprising weakened points, segments, and/or area(s), which may be created by scoring the seal **108**, designed to control the pattern of tearing. For example, FIG. **3** shows seal **108** as a fabric disk including weakened segments **128** outlining triangular sections **130**, wherein seal **108** is configured to tear at weakened segments **128** in accordance with various embodiments.

According to various embodiments, aspirator system **101** may further comprise an interior lining member **132**, which folds in the collapsed state, and extends to form a smooth interior of the channel in the extended state. According to various embodiments, interior lining member **132** extends at least partially through portion **116**, and may extend further according to various embodiments. An example is shown in FIG. **4**, where interior lining member **132** is attached to, and extends from telescoping segment **104** to telescoping segment **106**. In various embodiments, additional rim **134** has been added to provide an attachment site at telescoping segment **106** level with the attachment site to create an attachment point which is leveled with the attachment site at telescoping segment **104**. According to various embodiments, interior lining member **132** is made of a flexible material, such as fabric.

With reference to FIG. **4B**, according to various embodiments, an extension holder such as a spring **400** may be provided to facilitate maintenance of the extended state. In various embodiments, spring **400** (e.g. which may be a small wire diameter coil spring) may be wrapped around the outside walls **118** of aspirator barrel **112**, and captured between an additional rim **402** extending outwardly from outer lip **125** (e.g. opposite additional rim **134**) and top rim **120** of aspirator body **102**. In various embodiments, seal **108** (which may be a cap type seal) is bonded or otherwise attached at an attachment site **404** around top rim **120**, and serves to retain the spring **400**. In response to seal rupture, the spring **400** provides a mechanical extension force to bias portion **116** and aspirator barrel **112** to the extended state. According to various embodiments, spring **400** has a spring constant lower than what would be associated with shearing

the fabric cap, and may serve to extend aspirator barrel **112** in the event that the seal bursts before full extension.

According to an exemplary embodiment, an about 4 inch (10.16 cm) diameter aspirator barrel comprises two telescoping segments, and is approximately 18 inches (45.72 cm) long in its fully extended position. In its packed condition, the aspirator is approximately 9 inches (22.86 cm).

FIG. **5** illustrates an aspirator method **500**, according to various embodiments, which comprises pressurizing air channel **502**. In pressurizing air channel **502**, an air channel is pressurized with a gas, for example gas from a charged cylinder. The air channel may comprise extendable channel walls and be in a non-extended state. The method further comprises extending the air channel **504** via the pressurizing. The method further comprises bursting the seal **506** via the pressurizing. The channel may undergo resealing after bursting.

Additionally, an aspirator method according to various embodiments, may comprise sealing the air channel of a collapsible/extendable aspirator with a seal to create a pressurizable enclosure, wherein pressure against the seal is capable of extending the air channel, and wherein pressure against the seal is further capable of causing the air channel to unseal.

Systems and methods are provided. In the detailed description herein, references to “various embodiments”, “one embodiment”, “an embodiment”, “an example embodiment”, etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described. After reading the description, it will be apparent to one skilled in the relevant art(s) how to implement the disclosure in alternative embodiments.

Benefits, other advantages, and solutions to problems have been described herein with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any elements that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as critical, required, or essential features or elements of the invention. The scope of the invention is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean “one and only one” unless explicitly so stated, but rather “one or more.” Moreover, where a phrase similar to “at least one of A, B, or C” is used in the claims, it is intended that the phrase be interpreted to mean that A alone may be present in an embodiment, B alone may be present in an embodiment, C alone may be present in an embodiment, or that any combination of the elements A, B and C may be present in a single embodiment; for example, A and B, A and C, B and C, or A and B and C. Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims. No claim element herein is to be construed under the provisions of 35 U.S.C. 112(f) unless the element is expressly recited using the phrase “means for.” As used herein, the terms “comprises”, “comprising”, or any other variation thereof, are intended to cover

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a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus.

The invention claimed is:

**1.** An aspirator system comprising:

an air channel movable between a collapsed state and an extended state, said air channel comprising:

an aspirator body having a longitudinal axis,

an aspirator barrel in translating engagement with said aspirator body, and

a nozzle assembly disposed within said aspirator body, and configured to direct gas through said air channel; and

a pressure removable block, configured to seal said air channel in said collapsed state,

wherein said aspirator barrel is configured to extend from said aspirator body in response to a first pressure, said first pressure created in response to gas directed through said air channel against said pressure removable block, and

wherein said pressure removable block is configured to unseal said air channel in response to a second pressure, said second pressure created as gas is directed through said air channel against said pressure removable block, wherein said pressure removable block is a rupturable seal configured to tear upon application of said second pressure and bonded at an opening of said aspirator barrel.

**2.** The aspirator system of claim **1**, wherein said aspirator barrel is configured to extend from said aspirator body from a first axial length to a second axial length that is longer than the first axial length along said longitudinal axis, wherein said second pressure is created upon extension of said aspirator barrel to said second axial length.

**3.** The aspirator system of claim **2**, said aspirator body further comprising a rim configured to prevent said aspirator

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barrel from further translation upon extension of said aspirator barrel to said second axial length.

**4.** The aspirator system of claim **1**, wherein said second pressure is greater than said first pressure.

**5.** The aspirator system of claim **1**, wherein said rupturable seal is a fabric.

**6.** The aspirator system of claim **1**, said rupturable seal comprising a weakened segment, wherein said rupturable seal is designed to tear at said weakened segment.

**7.** The aspirator system of claim **1**, said aspirator barrel comprising an air channel exit, said pressure removable block disposed at the air channel exit and configured to seal said air channel at said air channel exit.

**8.** The aspirator system of claim **1**, said aspirator barrel being collapsible, and at least partially retainable within said aspirator body.

**9.** The aspirator system of claim **1**, further comprising an inflatable device configured to receive gas from said air channel.

**10.** The aspirator system of claim **1**, said aspirator barrel comprising a first telescoping segment and a second telescoping segment,

said first telescoping segment configured to extend from and collapse into said aspirator body, and

said second telescoping segment configured to extend from and collapse into said first telescoping segment.

**11.** The aspirator system of claim **1**, said air channel further comprising an interior lining member configured to fold in the collapsed state, and extend to form a smooth interior of said air channel in the extended state.

**12.** The aspirator system of claim **11**, said interior lining member comprising a fabric.

**13.** The aspirator system of claim **1** further comprising an extension holder configured to apply a mechanical extension force on said air channel.

**14.** The aspirator system of claim **13**, said extension holder comprising a spring.

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